Measurements of cross-sections of the proton-induced activation reactions on yttrium.

O M. S. Uddin[a], M.Baba[a] , M.Hagiwara[a], F. Tarkanyi[b] , and F. Ditroi[b]
[a]Cyclotron and Radioisotope Center, Tohoku University, Aramaki, Aoba-ku, Sendai 980-8578, Japan.
[b]Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen, H-4001, Hungary.

Yttrium is widely applied to increase the strengths of alloys of important metals of nuclear technology (aluminum, magnesium and chromium). The proton-induced activation cross-section on this element is important for dose determination in accelerator technology, for thin layer activation(TLA) of yttrium alloys (especially of aluminum and magnesium) and of yttrium oxide ceramics. Yttrium is a monoisotopic element therefore ideal target material to test nuclear reaction theories.

The ^{86,87,88}Y radioisotopes have value for investigation of the biodistribution of ^{90}Y labeled therapeutic compounds. ^{88}Y is a recognized standard for calibration of gamma-ray detector.^{88}Y is produced directly by particle-induced activation and/or via generator system from ^{88}Zr. We have investigated earlier the production possibility of the ^{88}Y by bombarding niobium and molybdenum targets with medium energy protons. Yttrium can also be used as target for large scale production of ^{88}Zr and ^{88}Y activities.

The longer lived radioisotopes of strontium are widely used for investigation and simulation of pollutant radioisotopes produced in power reactors (radio-strontium uptake by different biological systems like beans, teeth, organs, etc.).The Sr- and Rb-radionuclides have found applications in many fields of biology and of medicine. Particle-induced activation cross-sections on yttrium are important to provide information for the production of medically related radioisotopes, ^{82}Sr, ^{83}Sr, ^{85}Sr and biological tracers, ^{84}Rb, ^{83}Rb (water transports in plants, etc.).

The independent and “cumulative cross-sections” of the proton-induced reactions on yttrium were measured as a function of proton energy using a conventional stacked foil activation technique. Two stacks of several identical groups containing high purity thin yttrium foils (110 μm thick) were irradiated separately with 50 MeV (~165 nA for 30 min) and 80 MeV (~45 nA for 70 min) collimated proton beam respectively using the K=90 AVF cyclotron at Cyclotron and Radioisotope Center (CYRIC), Tohoku University, Sendai, Japan. In this way the proton beam energy range of 15-80 MeV was covered. The residual activity was measured nondestructively by high-resolution HPGe gamma-ray spectroscopy. The beam current was determined by the monitor reactions ^{nat}Cu(p,x)^{56}Co,^{62,65}Zn and ^{27}Al(p,x)^{22,24}Na. The cross-sections were deduced from the measured activities for ^{89,88,86}Zr, ^{88,87,87m,86}Y, ^{85,83,82}Sr and ^{84,83}Rb radionuclides using the well-known activation formula. The present work gives new data for all of the investigated radionuclides. In the most cases, our data are consistent with the results of Michel et al. (1997). The data in MENDL-2P deduced with the theoretical code ALICE-IPPE are consistent in shape with the measured values, but disagreement in magnitude. Application of the measured data in different field will be discussed.

Keywords: Activation cross-sections, Y+p reactions, 16-80 MeV, cyclotron.